



U.S. Army Tank-automotive and Armaments Command

*U.S. Army Armament Research, Development
and Engineering Center (ARDEC)*



“Warhead Technology Advancements”

NDIA

Armaments for the Army Transformation Conference

June 19-21, 2000

Presented by

Mr. Richard Fong

Warheads, Energetics & Combat-support Armaments Center



Committed to Excellence

Report Documentation Page

Report Date 19JUN2001	Report Type N/A	Dates Covered (from... to) -
Title and Subtitle Warhead Technology Advancements		Contract Number
		Grant Number
		Program Element Number
Author(s) Fong, Richard		Project Number
		Task Number
		Work Unit Number
Performing Organization Name(s) and Address(es) TACOM-ARDEC Warheads, Energetics & Combat-support Armaments Center		Performing Organization Report Number
Sponsoring/Monitoring Agency Name(s) and Address(es) NDIA (National Defense Industrial Association 2111 Wilson Blvd., Ste. 400 Arlington, VA 22201-3061		Sponsor/Monitor's Acronym(s)
		Sponsor/Monitor's Report Number(s)
Distribution/Availability Statement Approved for public release, distribution unlimited		
Supplementary Notes Proceedings from Armaments for the Army Transformation Conference, 18-20 June 2001 sponsored by NDIA		
Abstract		
Subject Terms		
Report Classification unclassified	Classification of this page unclassified	
Classification of Abstract unclassified	Limitation of Abstract UU	
Number of Pages 26		



Outline

- **Shaped Charges(SC)**
- **Explosively Formed Penetrator(EFP)**
- **Summary**



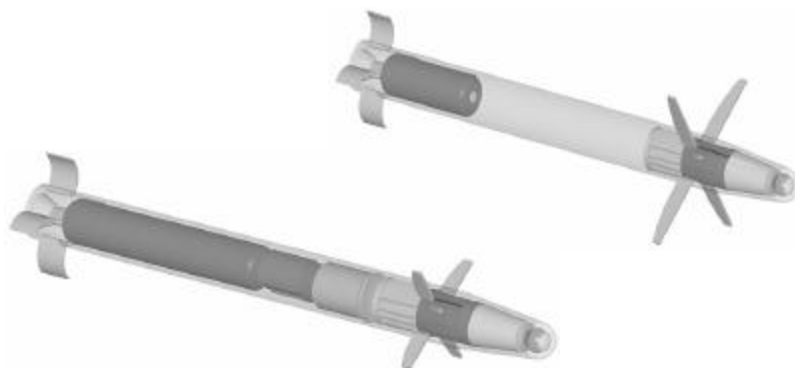
Enabling Warhead Technologies For FCS Munitions



3" SADARM



FCS Munitions



3" PGMM



Payoffs:

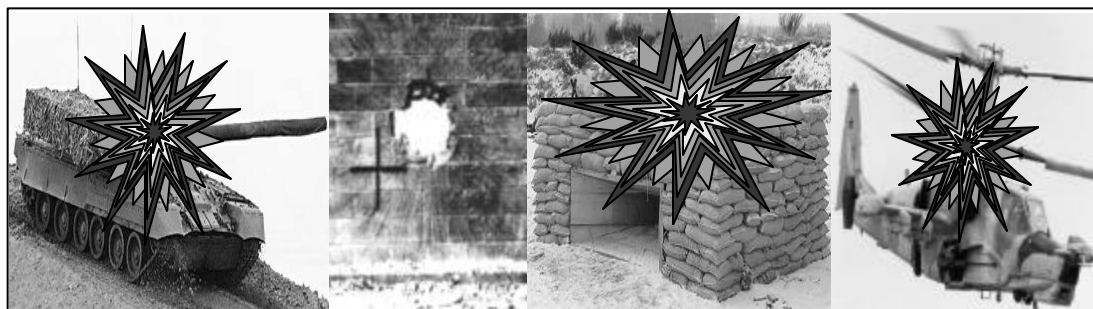
- **Smaller and lighter systems**
- **Multi-purpose capability**
- **Increased Lethality**
- **Counter APS**



TOW / FOTT



Common Missile



Committed to Excellence



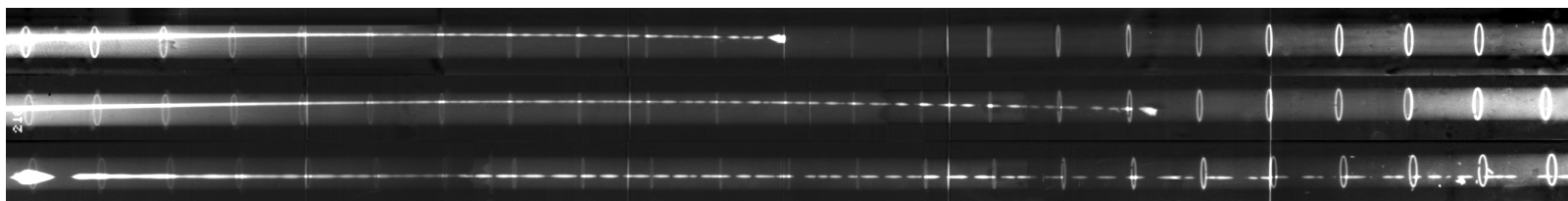
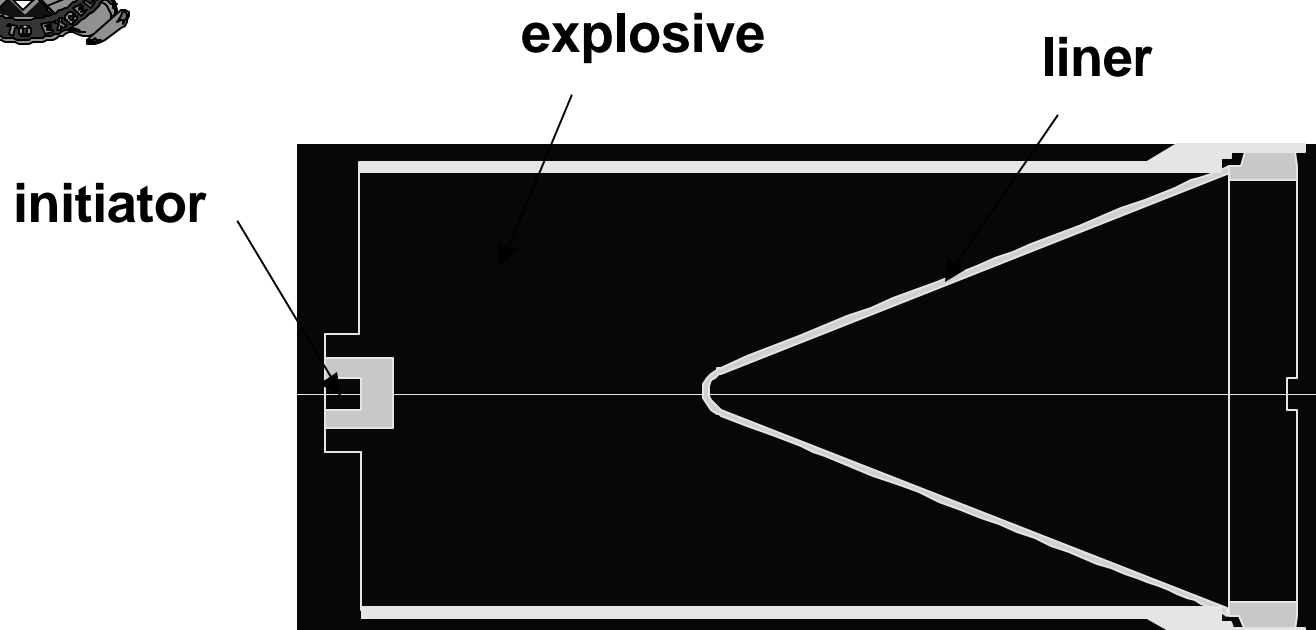
Shaped Charges (SCs)



- **Conventional SCs are employed in hit to kill systems such as Hellfire, Javelin**
- **High velocity gradient (for max length) and high tip velocity ~ 9 km/sec**
- **Produces deep penetration required for heavy frontal armor**
- **Copper conventionally used liner material, good ductility and tip velocity, Mo has higher tip velocity**



Shaped Charge Warheads



Jet Flash X-Rays
132ms, 162ms and 262ms

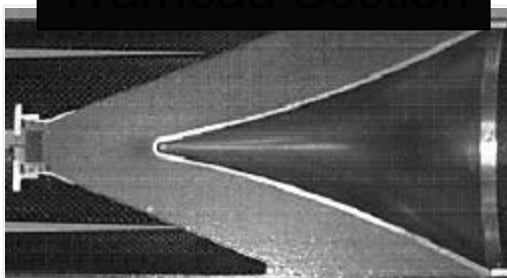
Committed to Excellence



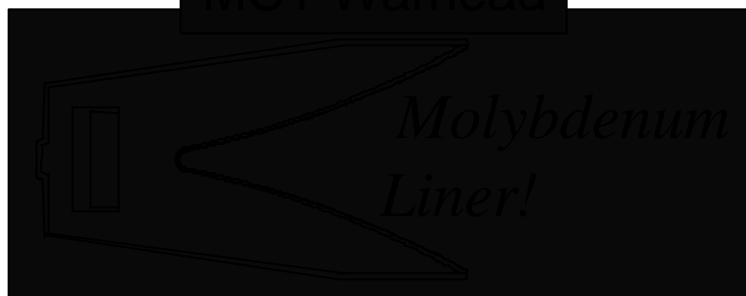
Heavy Armor SCs CL-20 & Mo Trumpets



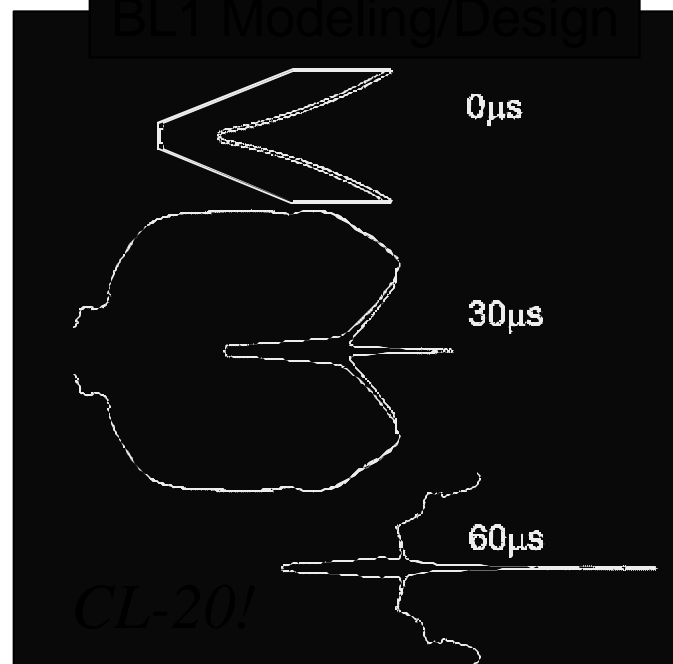
Warhead Section



MC1 Warhead



BL1 Modeling/Design



RHA Penetration



Committed to Excellence

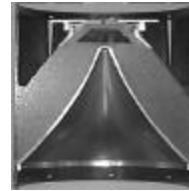


Warhead Technology Development Multi-purpose Shaped Charge



Armor Defeat

Bunker Defeat



Urban Warfare

**PENETRATION FOR
ARMOR TARGETS**



**PENETRATION/BLAST
FOR URBAN ATTACK**



**HIGH BLAST FOR
BUNKER COLLAPSE**



- *Selectable fuze*
- *High penetration provides high lethality against Armor*
- *Delay fuze provides high blast required for bunker defeat*
- *Pen/Blast combo provide increased Urban Capabilities!*
- *Inexpensive! Lightweight!*

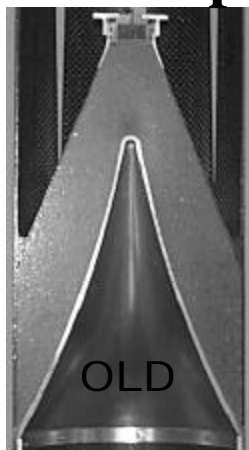
Committed to Excellence



Compact Multi-purpose SC Warhead Concept



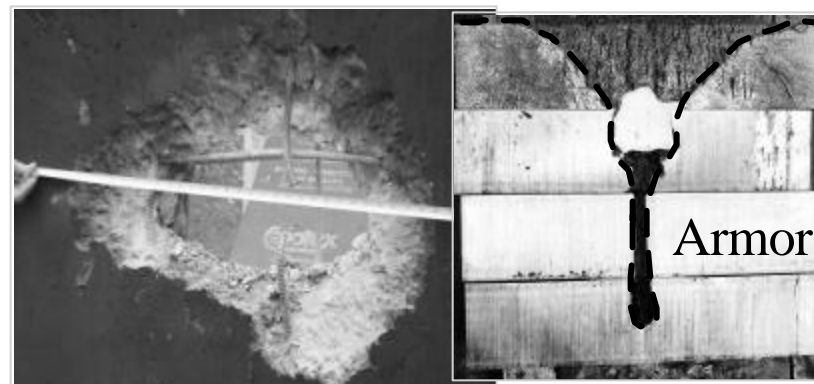
Compact Warheads



Shorter, lighter!

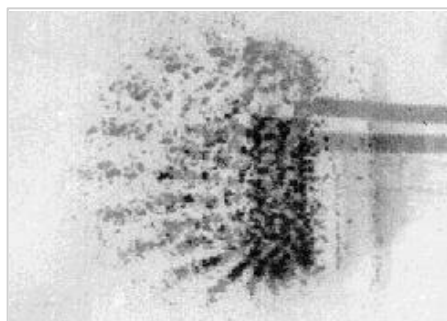


Wide Area Penetration



Defeat Walls & BMP!

Fragmentation/Blast



*Defeat Bunkers!
Defeat Helicopters!
Anti-personnel lethality!*

Multi-purpose

Deep Penetration *Defeat Tanks!*



Committed to Excellence



Explosively Formed Penetrator Warheads



**The Killer of Future Armored Target
used In Smart Munitions**

Why EFP ?

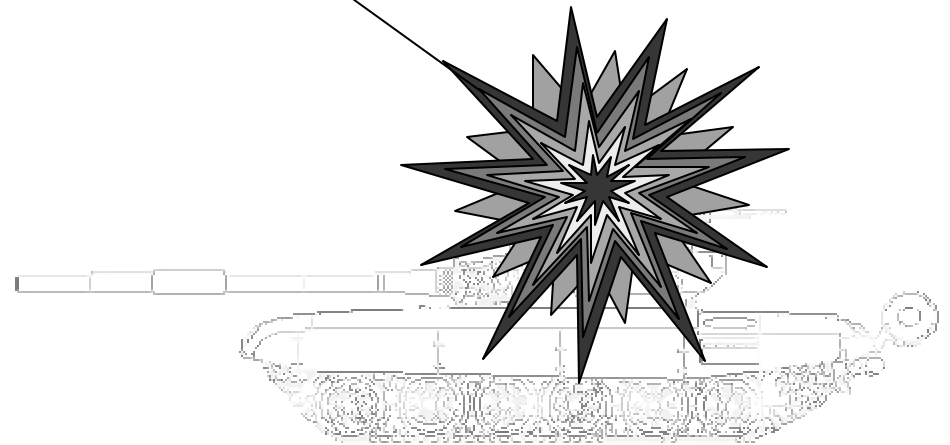
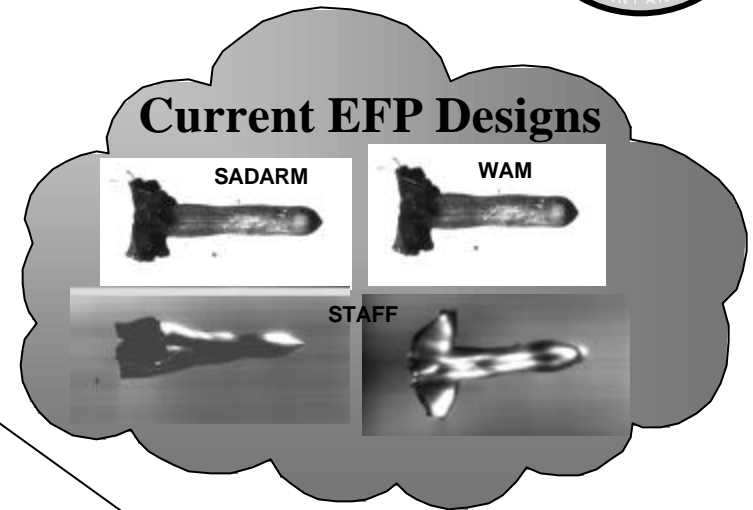
Potential Solution to Active Armor Threats

Long Standoff Target Defeat (Top Attack)

Less Affected by Reactive Armor

Large Hole / Increase Behind Armor Effects

Lower System Cost (Shoot to Kill System)



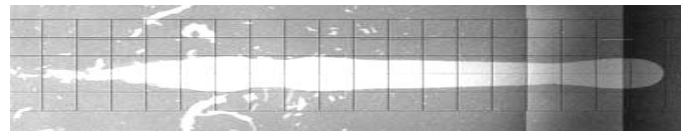
Committed to Excellence



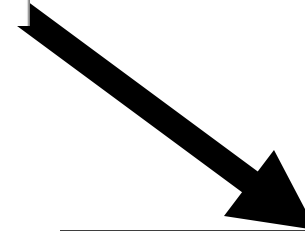
Explosively Formed Penetrator (EFP) Warhead



AEROSTABLE ROD



LONG STRETCHY ROD

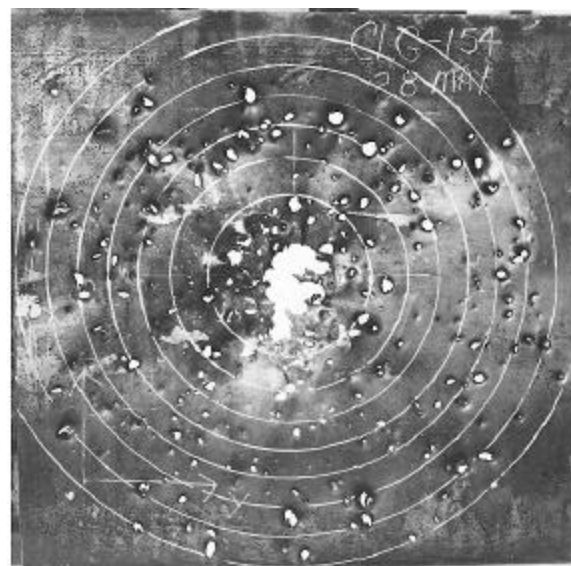
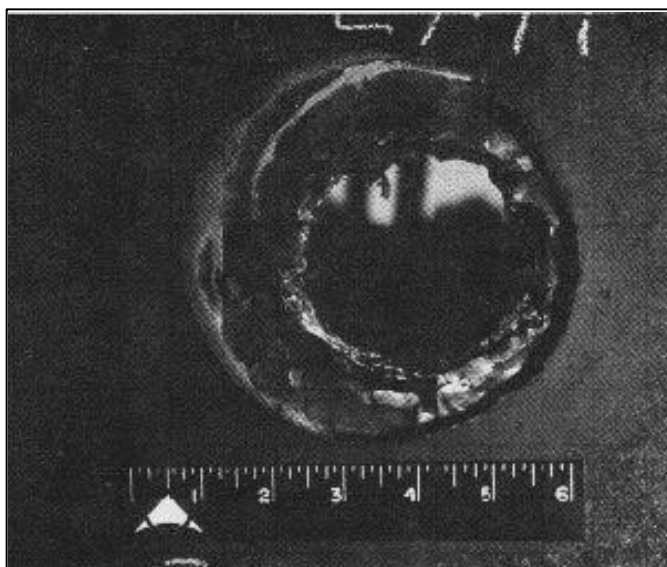
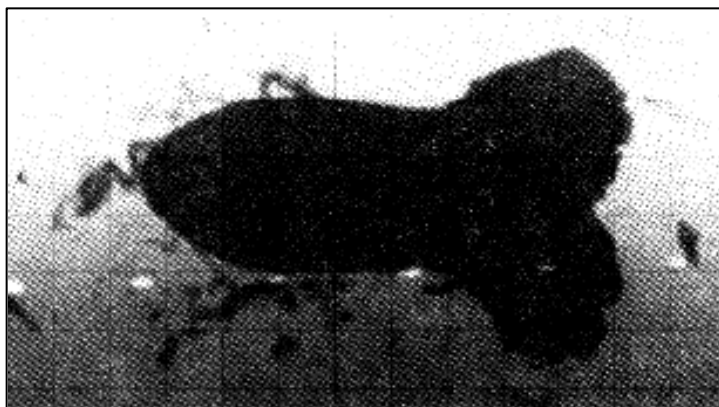


MEFP

Committed to Excellence



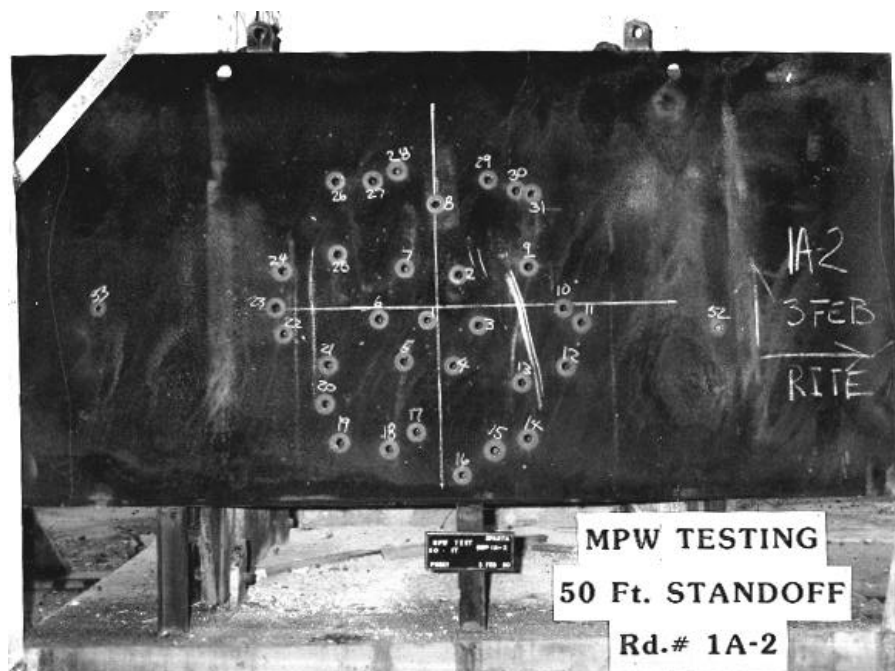
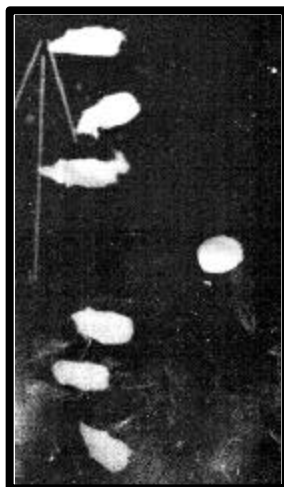
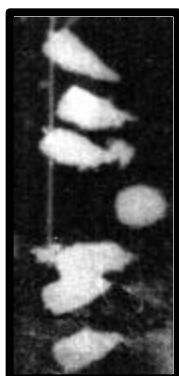
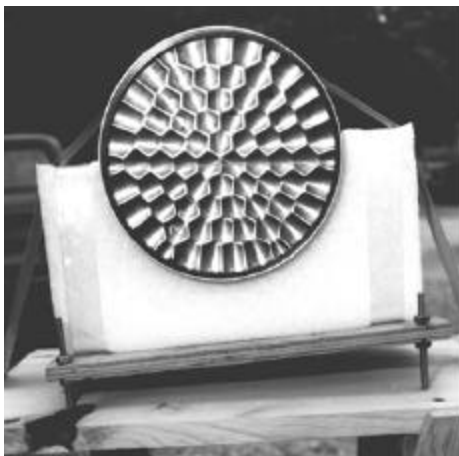
EFP Test Results



Committed to Excellence



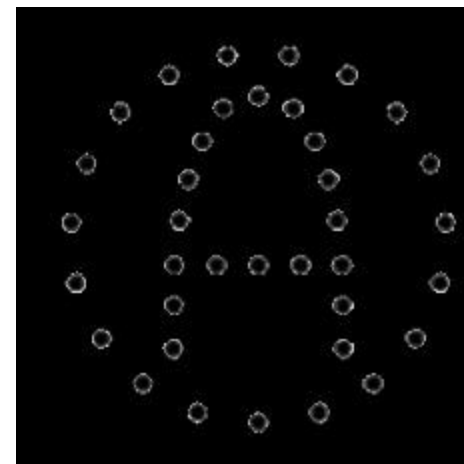
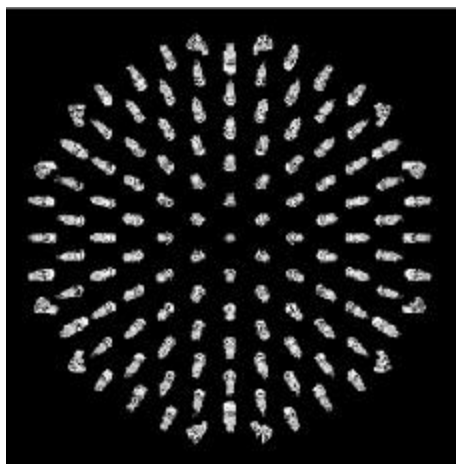
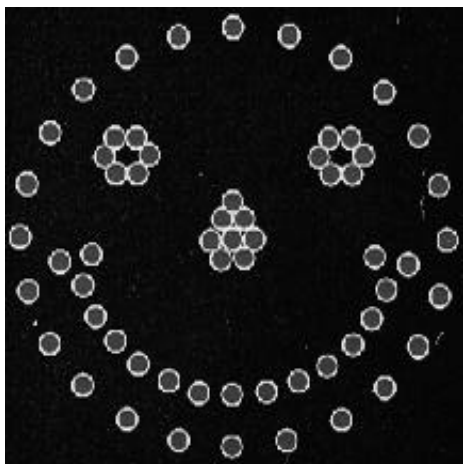
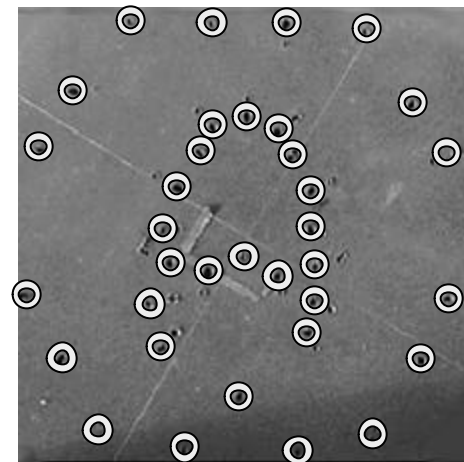
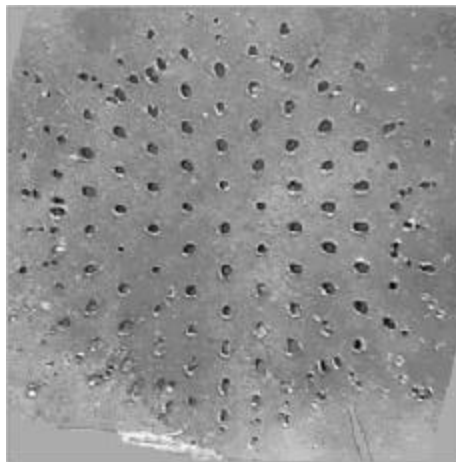
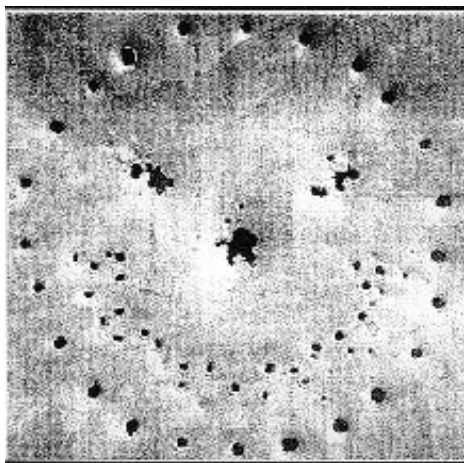
Multiple EFP Warhead



Committed to Excellence



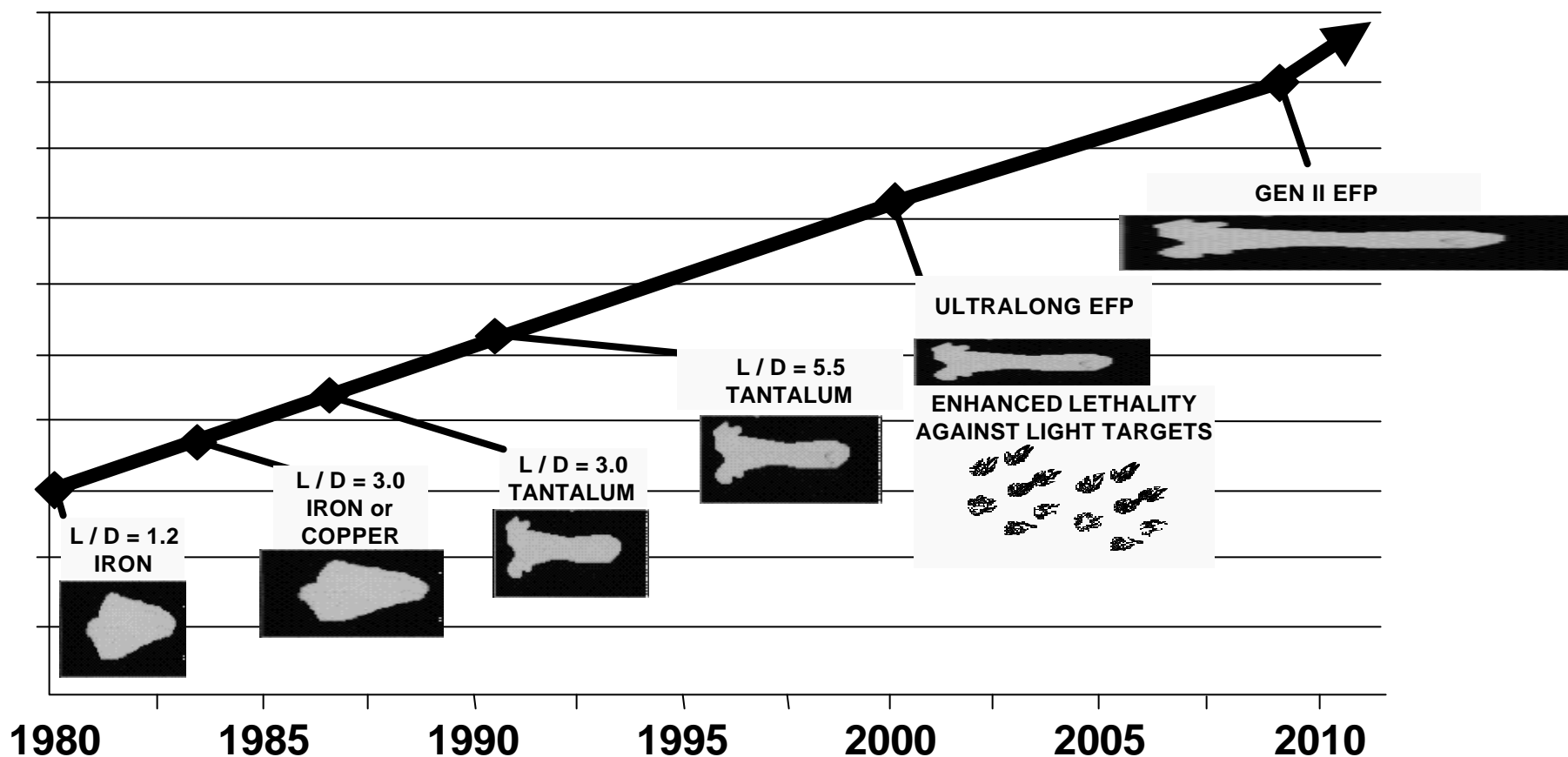
MEFP Warhead Pattern



Committed to Excellence



Lethality Growth of EFP Warheads



Committed to Excellence



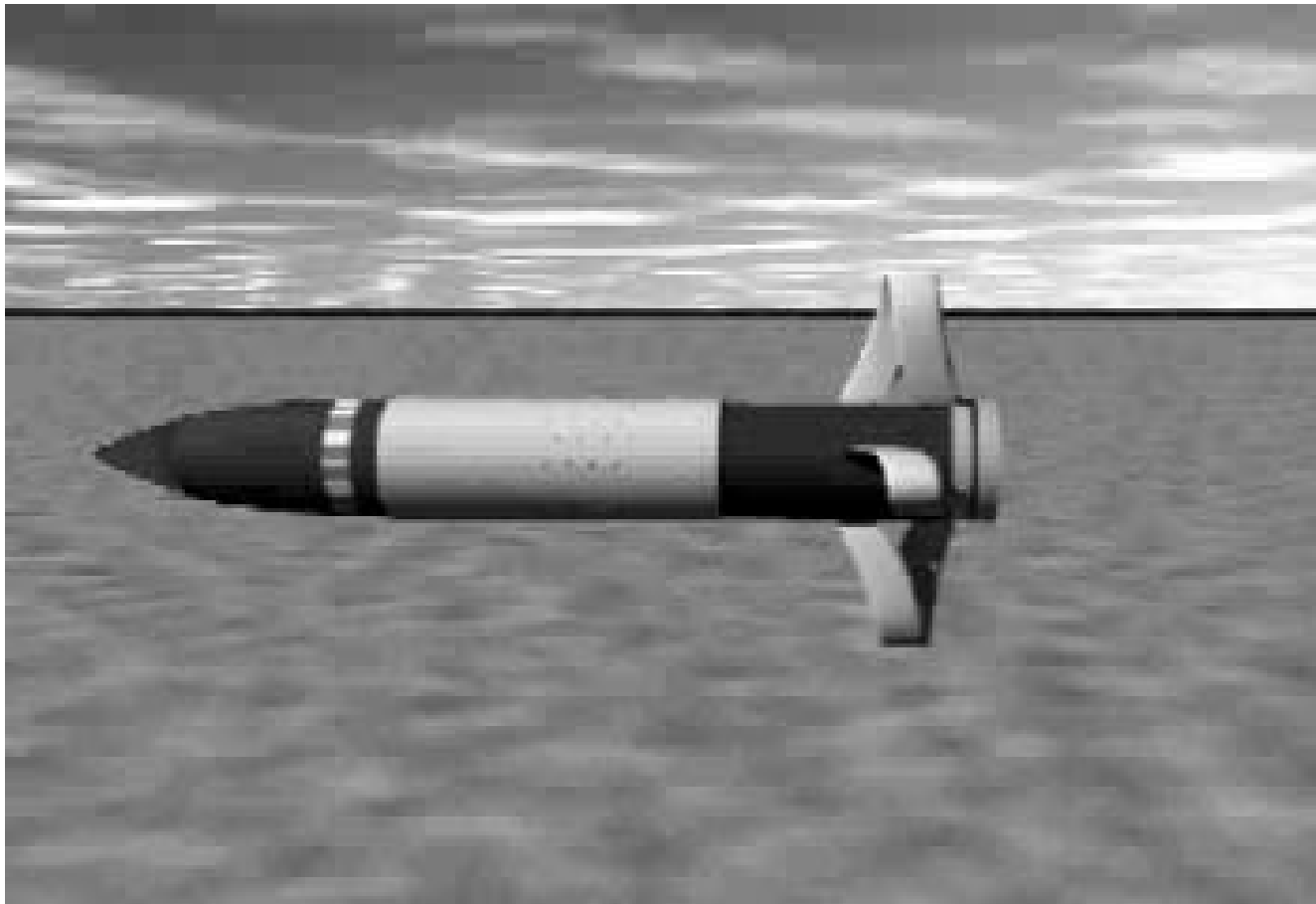
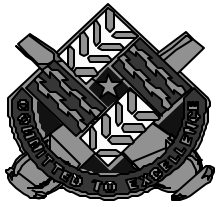
EFP WARHEADS FOR FCS MUNITIONS



GOALS: Develop Smaller, More Lethal, Multi-Purpose, Longer Standoff EFP warheads to defeat Full Spectrum of Targets.

APPROACHES:

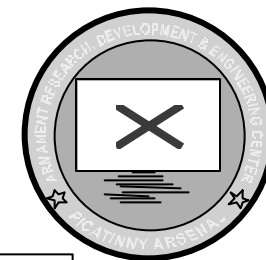
- **Penetration** - Collinear EFP
 - Enhanced Single Liner (ESL)
 - Gen II EFP
- **Multi-Purpose** - Selectable EFP
 - Combined Effects EFP



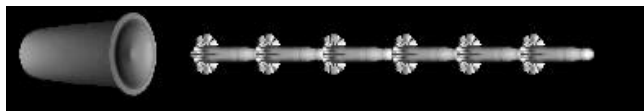
Committed to Excellence



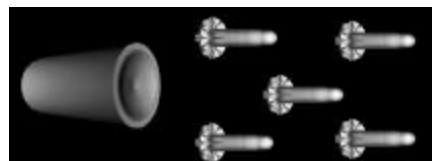
Multimode/Multiple Target EFP Warhead



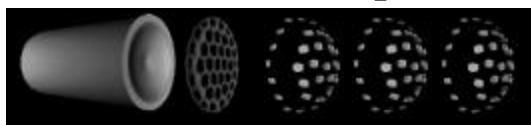
Mode 1: Main Battle Tanks (MBT)



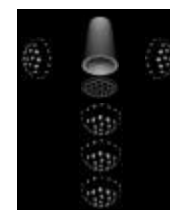
Mode 2: Armored Personnel Carriers (APC)



Mode 3: Helicopters



Mode 4: Anti-personnel

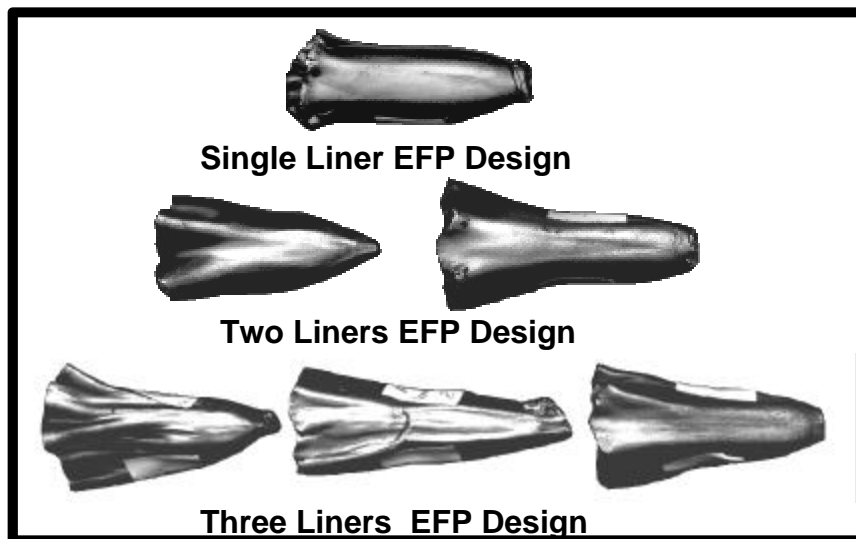
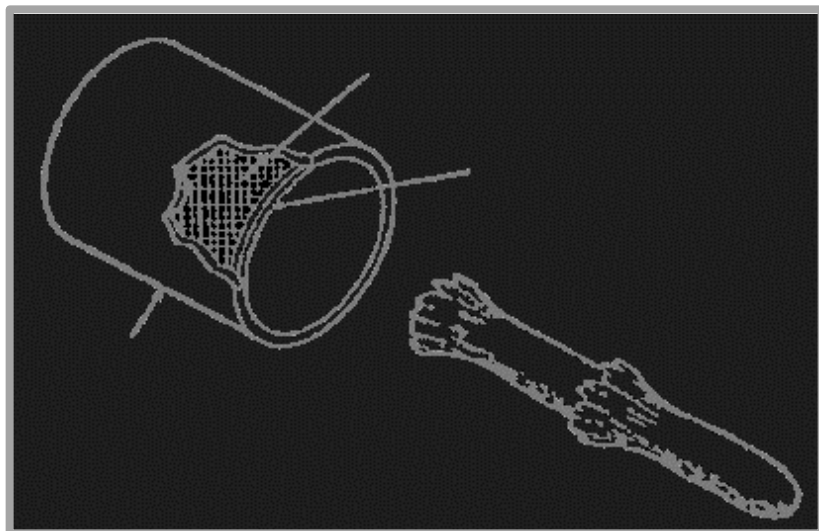


Mode 5: Anti-obstacle- Tank traps, concrete and masonry structures

Committed to Excellence



Collinear EFP Warhead



Time = 200 μ s



Time = 500 μ s



Time = 850 μ s

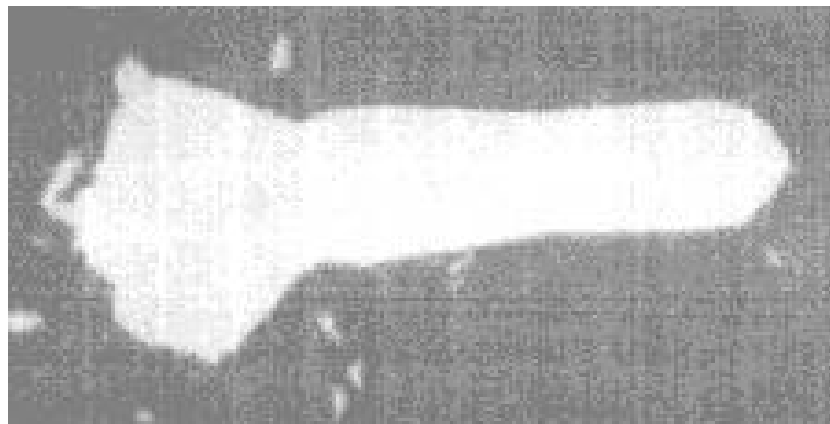
Committed to Excellence



Enhanced Single Liner (ESL) EFP Warhead



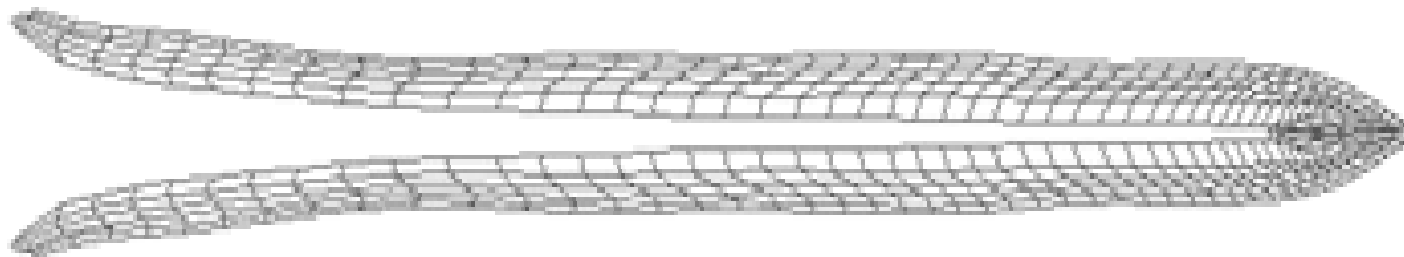
Current



ESL



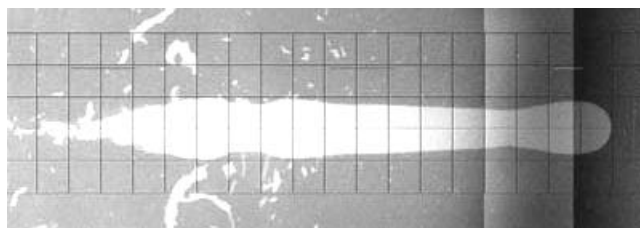
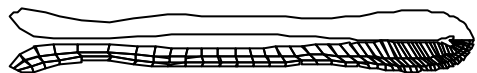
**COMPUTER
SIMULATION**



Committed to Excellence



Silver EFP Design



Entrance



Exit



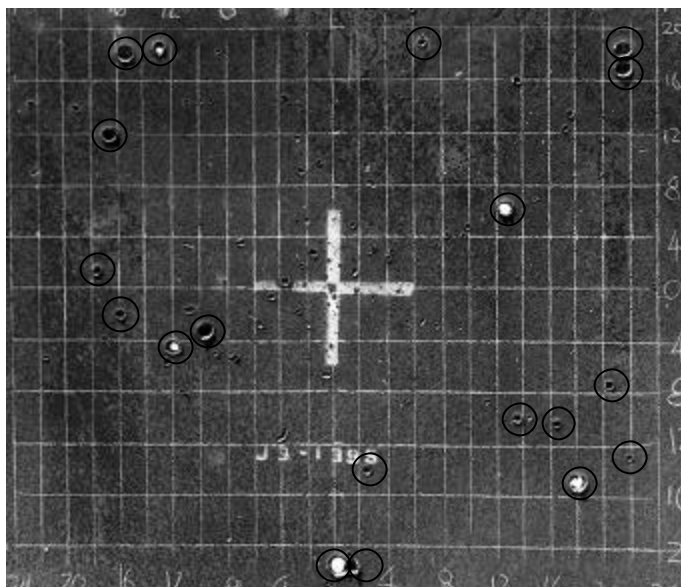
Committed to Excellence



Selectable EFP Warhead



Long Standoff EFP



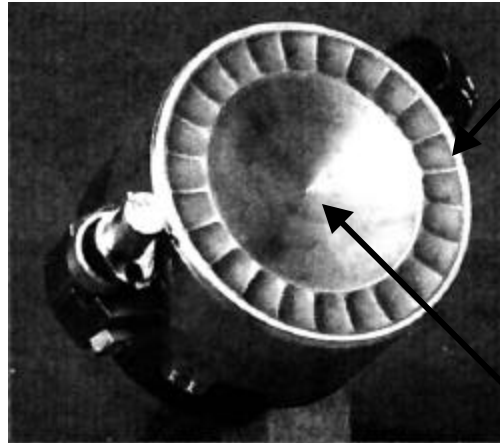
Multiple EFP Test Results



Short Standoff EFP

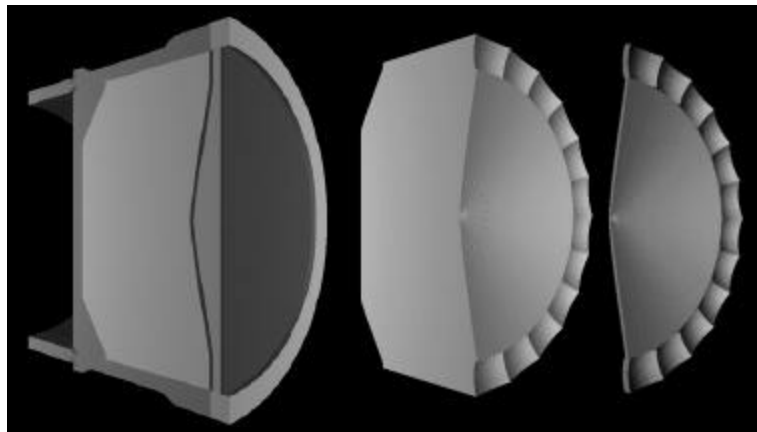
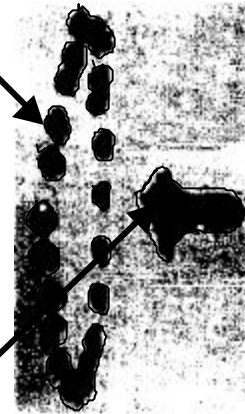


Multi-Mission/Multi-Purpose “Combined Effects” Warhead



**Ring of compact
secondary EFPs**

Center main EFP

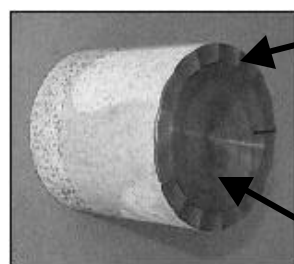


Computer Model

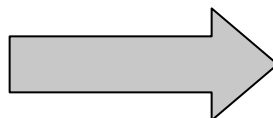
- **Combined Effects Warhead**
 - **Subcaliber main EFP for the defeat of primary target**
 - **Ring of smaller secondary EFPs for increased effectiveness against secondary targets**



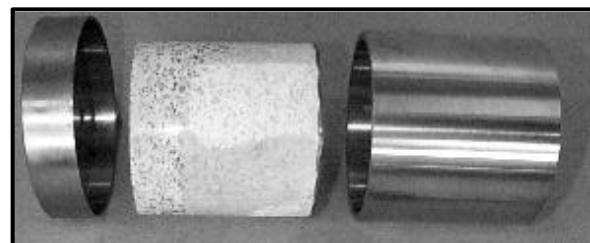
Mult-Purpose Combined Effects Warhead



16-MEFP's

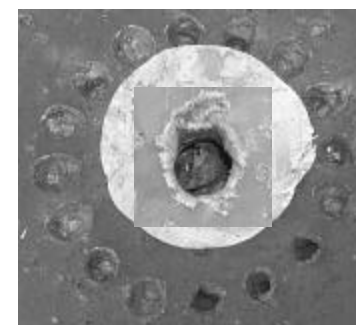
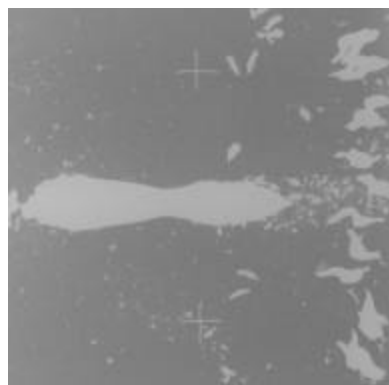
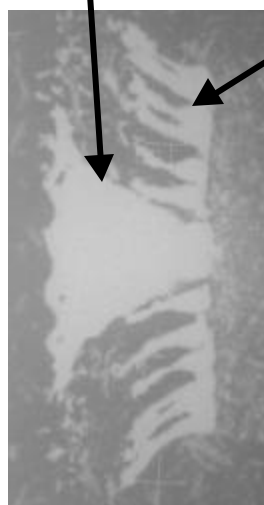


1-SEFP



SEFP

MEFP

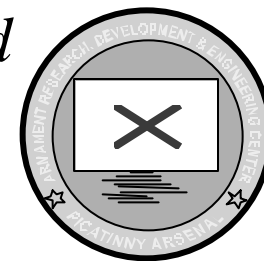


Target
Photograph

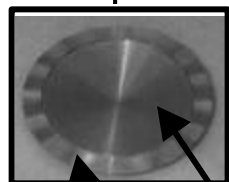
Committed to Excellence



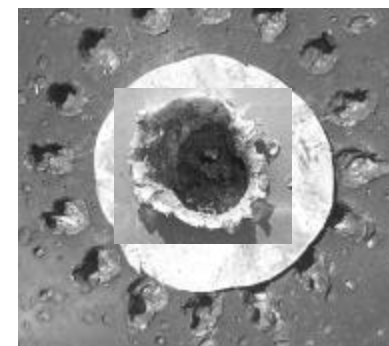
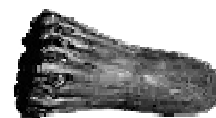
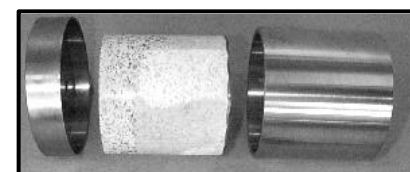
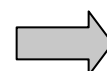
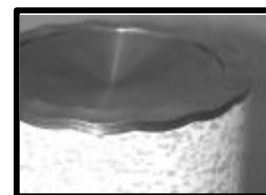
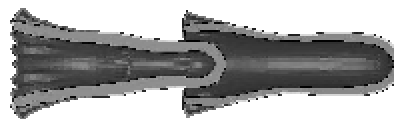
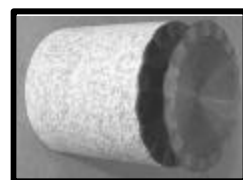
Collinear Multit-Purpose Combined Effects Warhead



+



16-MEFP's SEFP



Target Photograph

Committed to Excellence



Special Operation Forces Demolition Kit Warhead

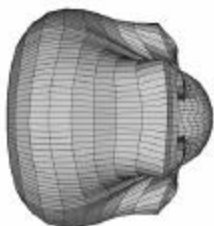


Baseline Medium Size EFP Warhead

Hit Point Accuracy



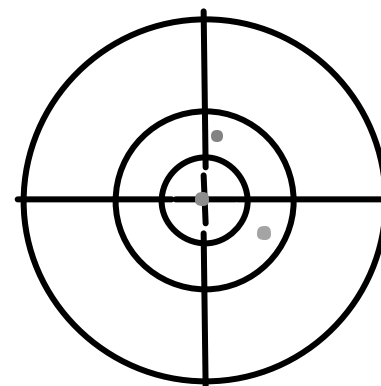
**3D Computer
Simulation**



**Cordin Photo
of EFP in Flight**

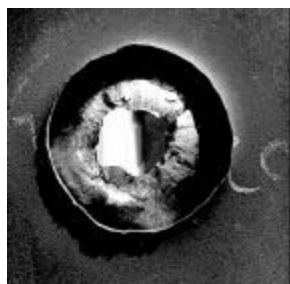


Flash X-Ray



24-inch Radius
12-inch Radius
6-inch Radius

- 50 ft.
- 100M
- 150M



RHA Target (Exit)



Concrete Wall (Exit)



Brick Wall (Exit)

Committed to Excellence



Summary

- **Major Advances in Shaped Charge & EFP Warheads**
 - Innovative Warhead Concepts
 - Improved Modeling Capabilities
 - Improved Designs
- **Developing Enabling Technologies & Advanced Warheads for FCS Munitions**
(smaller, lighter, more lethal)